World Aero Markets: Looking Up, From The Bottom of a Pit

World Aircraft Overview
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August 2021
# Aircraft Markets, In Good And Bad Years
(last year was not good)

<table>
<thead>
<tr>
<th>World New Deliveries</th>
<th>CAGR '03-'08</th>
<th>CAGR '08-'14</th>
<th>CAGR '14-'19</th>
<th>Change '19-'20</th>
</tr>
</thead>
<tbody>
<tr>
<td>In 2020 (2021 $)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jetliners-SA ($27 b)</td>
<td>9.7%</td>
<td>6.9%</td>
<td>-2.0%</td>
<td>-54.8%</td>
</tr>
<tr>
<td>Jetliners-TA ($27.8 b)</td>
<td>5.0%</td>
<td>13.5%</td>
<td>2.1%</td>
<td>-49.1%</td>
</tr>
<tr>
<td>Regionals ($3.4 b)</td>
<td>3.9%</td>
<td>-3.1%</td>
<td>-6.3%</td>
<td>-47.8%</td>
</tr>
<tr>
<td>Business Aircraft ($18.2 b)</td>
<td>16.7%</td>
<td>-2.2%</td>
<td>-1.2%</td>
<td>-15.7%</td>
</tr>
<tr>
<td>Civil Rotorcraft ($3.1 b)</td>
<td>18.5%</td>
<td>-2.5%</td>
<td>-7.2%</td>
<td>-11.4%</td>
</tr>
<tr>
<td>Military Rotorcraft ($10.7 b)</td>
<td>10.6%</td>
<td>9.7%</td>
<td>-7.0%</td>
<td>-16.3%</td>
</tr>
<tr>
<td>Military Transports ($4.1 b)</td>
<td>3.2%</td>
<td>-0.9%</td>
<td>0.0%</td>
<td>-27.0%</td>
</tr>
<tr>
<td>Fighters ($18.3 b)</td>
<td>1.6%</td>
<td>0.8%</td>
<td>6.1%</td>
<td>-22.6%</td>
</tr>
<tr>
<td>All Civil ($79.9 b)</td>
<td>9.7%</td>
<td>5.6%</td>
<td>-0.5%</td>
<td>-40.0%</td>
</tr>
<tr>
<td>All Military ($36.9 b)</td>
<td>3.9%</td>
<td>4.1%</td>
<td>0.0%</td>
<td>-18.4%</td>
</tr>
<tr>
<td>Total ($116.7 b)</td>
<td>8.0%</td>
<td>5.2%</td>
<td>-0.4%</td>
<td>-34.5%</td>
</tr>
</tbody>
</table>
## Aviation Segments By Damage

### Most to Least Annotated, 18 Months In

<table>
<thead>
<tr>
<th>Segment</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Jets</td>
<td>Large cabin strongly correlated with oil prices. Small/medium strongly correlated with corporate profits, equities indices. Recovering quickly; just a 2020/21 downturn</td>
</tr>
<tr>
<td>Civil Rotorcraft</td>
<td>Oil and gas segment (large) hit again, before recovery even began. About right...wait and see.</td>
</tr>
<tr>
<td>Military Programs</td>
<td>Emphasis on “shovel-ready.” Advance development programs at greater risk. Pure-play contractors in best shape; suppliers with most defense in best shape. All good. In fact, better.</td>
</tr>
</tbody>
</table>
Traffic: Nothing We've Ever Seen Before
-65.9% RPKs in 2020 (-56.5% ASKs; -10.6% FTKs)
2019 Totals: RPKs 4.2%, ASKs 3.4%, FTKs -3.3%
2018 Totals: RPKs 6.5%, FTKs 5.4%; 2017: RPKs 7.6%, FTKs 9%

Source: IATA

Y/Y; Starting March 2021, comps are with same month, 2019
More Unprecedented Numbers

- Traffic decline, parked fleet like no previous shock.
  - Per Paul Krugman, reflect a world economy recovering from a “medically-induced coma.”
- Backlogs holding up (MAX stabilizing), but meaningless for production rates in a downturn.
- Many early retirements coming, particularly twin aisles.
  - Primarily twin aisles; Quadjet bloodbath, especially A380.
- Aftermarket catastrophe – ASK decline, plus de-stocking, deferred maintenance, early retirements, USM, engine swapping, etc.
  - But promise of an equally swift recovery.
Traffic Peak Recovery By Late 2022. Why?

- Better-than-expected vaccine efficacy.
- Better-than-expected economic outlook.
- The China and US domestic comebacks.
- Business travel resurgence.
- Vacation travel resurgence, fueled by record savings rates.

Concern about Delta and other variants…it’s the big variable.

Here It Is, The Chart I Was Dreading

'68-'77
-11 CAGR; 65% peak-to-trough

'78-'80
13% CAGR; 47% peak-to-trough

'80-'84
-13.9% CAGR; -45% peak-to-trough

'84-'91
16.1% CAGR

'91-'95
-12.5% CAGR; 41% peak-to-trough

'95-'99
20.8% CAGR

'99-'03
-11 CAGR; 65% peak-to-trough

'01-'03
-10.7% CAGR; 28.8% peak-to-trough

Or

'04-'18
8% CAGR
A 14-Year Super Cycle

Welcome back to 2006
Interest Rates And Oil Prices: Less Than 4%, And $50-85/bbl, Ideally; But The Ratio Matters Most

COVID-19 Pressuring Both Downward; recovery pressuring fuel upward (with risk to interest rates); Goldilocks outcome?
2000: China is 2% of world market

2018: China is 23% of world market
Large Jetliner Orders And Deliveries
Book-To-Bill No Longer A Thing
The Air Transport Market By Segment
A Tale of Two Markets

Deliveries In 2021 $ Billions

Regionals
Single Aisles
Twin Aisles

Too much, too sudden
(A330s, 777s, 787s, Gulf carriers, etc.)

737MAX Problem, and flood;
includes delivery of
~450 already-built jets

Return to peak: 2023

Now With Greater Misery

Hit Hardest and Longest; Capacity hangover, international traffic problems, and shift towards single aisles

Return to peak: after 2030... probably
Single Aisle Deliveries: Protected By MAX Return, and By Shift Away From Twin Aisles
Twin Aisles: Formerly Hot; Now Crowded And Depressed

Deliveries in 2021 $ Bns

- A350
- A330
- A330neo
- A340
- A380
- B767
- B777
- B777X
- B787
- B747

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Twin Aisles Have Been Here Before

• We’re forecasting a lasting shift towards single aisles, with profound consequences for primes, suppliers, and jetliner financing. But twins have been in dire straits several times before.

• Twins may bounce back:
  • Belly cargo (Asia/Mideast connectors).
  • Range (Asia/Mideast connectors).
  • Post-fragmentation route thickening (legacies gaining, International LCCs losing).
Firm Order Backlog Values: Boeing Taking A Hit

2021 $Billions

<table>
<thead>
<tr>
<th>Year</th>
<th>Boeing</th>
<th>Airbus</th>
<th>Bombardier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1h 1997</td>
<td>130.0</td>
<td>48.6</td>
<td>—</td>
</tr>
<tr>
<td>1h 2001</td>
<td>107.8</td>
<td>112.9</td>
<td>—</td>
</tr>
<tr>
<td>End 2004</td>
<td>79.5</td>
<td>115.5</td>
<td>—</td>
</tr>
<tr>
<td>End 2006</td>
<td>199.1</td>
<td>173.0</td>
<td>—</td>
</tr>
<tr>
<td>End 2008</td>
<td>300.4</td>
<td>281.8</td>
<td>—</td>
</tr>
<tr>
<td>End 2009</td>
<td>271.1</td>
<td>268.2</td>
<td>—</td>
</tr>
<tr>
<td>End 2010</td>
<td>270.0</td>
<td>277.6</td>
<td>—</td>
</tr>
<tr>
<td>End 2011</td>
<td>300.1</td>
<td>309.5</td>
<td>1.9</td>
</tr>
<tr>
<td>End 2012</td>
<td>317.0</td>
<td>321.6</td>
<td>3.3</td>
</tr>
<tr>
<td>End 2013</td>
<td>365.3</td>
<td>399.9</td>
<td>4.9</td>
</tr>
<tr>
<td>End 2014</td>
<td>421.2</td>
<td>439.9</td>
<td>5.5</td>
</tr>
<tr>
<td>End 2015</td>
<td>412.9</td>
<td>461.2</td>
<td>6.7</td>
</tr>
<tr>
<td>End 2016</td>
<td>398.9</td>
<td>468.1</td>
<td>9.0</td>
</tr>
<tr>
<td>End 2017</td>
<td>402.1</td>
<td>441.8</td>
<td>9.0</td>
</tr>
<tr>
<td>End 2018</td>
<td>408.0</td>
<td>481.6</td>
<td>8.7</td>
</tr>
<tr>
<td>End 2019</td>
<td>378.8</td>
<td>463.6</td>
<td>8.5</td>
</tr>
<tr>
<td>End 2020</td>
<td>297.1</td>
<td>438.9</td>
<td>—</td>
</tr>
<tr>
<td>May 1 2021</td>
<td>275.9</td>
<td>426.4</td>
<td>—</td>
</tr>
</tbody>
</table>
Airbus, Boeing Jetliner Backlogs (August, w/ ASC 606)

- <150 Single aisle
- 150 Single aisle
- 200 Single Aisle
- 250-300 Twin aisle
- >300 Twin aisle

Boeing and Airbus backlogs compared for different categories of jetliners.
Disconnect Between Single and Twin Aisle Economics; Explains 757/767

**Realized Price/Seat**

- B737-800
- A320
- A321neo
- B737MAX9
- A330-200
- A330-600
- A350-900
- B767-300ER
- B787-8

**Block Hour Cost Per Seat**

- B737-800
- A320
- A321
- B757-200
- A330-200
- B767-300ER
- B787-8
Boeing Commercial IR&D: Under Pressure Again
Airbus Commercial IR&D: More Spend, Less Discipline…Until 2015
And Where Is It Going Now?

Airbus IR&D

As % of Airbus Commercial Sales

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Jetliner Market Shares By Deliveries

Airbus Seizes The Middle Market and First Place; Covid-19 Accelerates shift to Middle Market

Deliveries in 2021 $Billions

Boeing  
Airbus ex 321neo  
A321neo  
COMAC/Irkut

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We'll Get Back To The Road We Were On
(as long as we're talking single aisles)
Realized Prices Versus Production Costs

PPI For Aircraft Manufacturing per FRED (Value Source: Airline Monitor); 2002 baseline = 100 (baseline 2014 Neo and 2016 MAX)

High Defense Spending Greatly Complicates This Picture...
Regional Deliveries By OEM (Value)
Business Aircraft Market History (w/jetliners, RJs, turboprops)

- The Great Expansion; strong economic growth, new models, fractional, etc.
- The 2003-08 Boom.
- The Great Bifurcation, followed by unwelcome convergence.
- Post-tech/comms and 9/11 bust.
- Smaller plane boom; some military Learjet distortion.
- Market creation; initial demand sated.
- The great stagnation.

Value of Deliveries in 2021 $ Bns

Units

Value

Value

Units

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Bottom Half Bizjet Segment vs. Top Half

'03-'08 CAGR: 19.7% Bottom, 15.3% Top

'10-'19: 4.3% Bottom, 0.3% Top

'08-'10: -56.8% Bottom, 3.5% Top

Market Value in '21 $Billions

Bottom Half (<$26M) Jan 2020
Eight Contradictory Bizav Indicators

• Three Leading Market Indicators:
  • Corporate profits (sharply down, but back up again).
  • Equities markets (good/excellent).
  • Oil prices (from very bad to rather good).

• Five Immediate Market Health Indicators:
  • Deliveries (bad, but looking up)
  • Aircraft available for sale (just modestly up…very good news… and now tightening again).
  • Aircraft prices (down somewhat, but nicely up in May).
  • Company layoffs (GD, BBD, TXT…seem to have ended).
  • Utilization (down, but recovering much faster than airline travel, with charter and fractionals looking great).
Business Jet Manufacturer Market Shares
By Deliveries Value, 2011-2020 vs. 2021-2030

Excludes jetliners, RJs and turboprops

- Bombardier: 31.9% (2011-2020), 28.6% (2021-2030)
- Hawker: 0.8% (2011-2020), 0.0% (2021-2030)
- Dassault: 14.0% (2011-2020), 14.0% (2021-2030)
- Cessna: 10.0% (2011-2020), 11.6% (2021-2030)
- Gulfstream: 36.9% (2011-2020), 36.3% (2021-2030)
- Embraer: 5.3% (2011-2020), 6.1% (2021-2030)
- Other: 0.7% (2011-2020), 3.4% (2021-2030)

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Embraer: Searching For Growth After The E-Jet Revolution

Value of Deliveries in 2020 $ Bns

- E-Jets
- E-2
- ERJ Series
- EMB120
- Tucano
- AMX
- KC-390
- Gripen
- Phenom 100/300
- Legacy 450/500
DoD Investment: Much Better Than In The Last Jetliner Downturn

- Procurement
- RDT&E
- O&M
No Clear Relationship Between US Defense Spending, Economy
Also No Clear Relationship Between Export Markets, Resource Prices
(Or any other economic indicator)
DoD Tactical Aircraft Procurement

- Funding
- Units

Units Procured

Funding in FY20 $ Billions

FY86, FY88, FY90, FY92, FY94, FY96, FY98, FY00, FY02, FY04, FY06, FY08, FY10, FY12, FY14, FY16, FY18, FY20, FY21
World Fighter Production Shares

(Value of Deliveries in '21 $ Billions)

- F-35 US
- F-35 International
- Undetermined
- Europe
- Russia
- RoW
- Non-F-35 US
Deliveries in 2021 $ Billions

US Military Fixed Wing Aircraft Deliveries

C-17  AV-8B  F/A-18  F-15  F-16  F-22  T-45  T-6  C-130  F-35  T-7  B-21
European Military Aircraft Deliveries
Coping Without F-35...To A Point;
Germany, France, UK Fighter Decisions Loom

Deliveries in 2021 $ Billions

Eurofighter
Rafale
Gripen
Tornado
Mirage 2000
A400M
Trainers
Other Transports
The World Rotorcraft Market
The Age of Diminished Expectations

Value (2021 $ Billions)

Units Delivered
US Military Rotorcraft Market Falling; International Military and Civil Stable

- Civil
- Military (US)
- Military (International)
## Global Aircraft Market Outlook In One Page

(Deliveries, *not* Production)

<table>
<thead>
<tr>
<th>Segment</th>
<th>2021</th>
<th>’21–’22</th>
<th>Risk</th>
<th>Elevator Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jetliners-SA</td>
<td>56.4%</td>
<td>31.5%</td>
<td>Green</td>
<td>Includes some already-built MAXs. Watch China, fuel, traffic.</td>
</tr>
<tr>
<td>Jetliners-TA</td>
<td>-1.8%</td>
<td>11.5%</td>
<td>Red</td>
<td>Overcapacity, slow international recovery, secular shift to SAs; 787 inventory issue</td>
</tr>
<tr>
<td>Regionals</td>
<td>-0.3%</td>
<td>10.9%</td>
<td>Green</td>
<td>No Boeing supply chain effect on E-2; Scope clause de-risked, but little growth.</td>
</tr>
<tr>
<td>Business Aircraft</td>
<td>-6.7%</td>
<td>8.0%</td>
<td>Green</td>
<td>Another hit after many false starts over a disappointing decade.</td>
</tr>
<tr>
<td>Civil Rotorcraft</td>
<td>0.1%</td>
<td>12.9%</td>
<td>Red</td>
<td>Large civil hit again. Too many new models aimed at a weak segment (oil/gas).</td>
</tr>
<tr>
<td>Military Rotorcraft</td>
<td>1.5%</td>
<td>3.0%</td>
<td>Green</td>
<td>Programs end/slow; no risk of accelerated downturn; FVL beyond forecast, exc FARA.</td>
</tr>
<tr>
<td>Military Transports</td>
<td>-2.8%</td>
<td>-1.4%</td>
<td>Green</td>
<td>A seriously underperforming market.</td>
</tr>
<tr>
<td>Fighters</td>
<td>29.2%</td>
<td>12.6%</td>
<td>Green</td>
<td>I like this market. F-35 (after COVID disruption), plus strong Gen 4.5</td>
</tr>
<tr>
<td>All Civil</td>
<td>16.4%</td>
<td>19.7%</td>
<td>Red</td>
<td>SAJetliner snapback due to MAX, weakness in other segments; more overcapacity risk.</td>
</tr>
<tr>
<td>All Military</td>
<td>14.9%</td>
<td>8.4%</td>
<td>Green</td>
<td>Global insecurity, Tension, Malice. Special mission (ISR, B-21) also boosts topline.</td>
</tr>
<tr>
<td>Total Industry</td>
<td>15.9%</td>
<td>16.2%</td>
<td>Red</td>
<td>Back to peak in 2024</td>
</tr>
</tbody>
</table>
Top 20 Aviation Programs; Volume Matters
Cumulative Deliveries Value in ’21 $ Bns

Top 5 are 56% of total; next 15 are 21%; remaining 100+ are 23%. And...the A320 (321) throws shade on everyone.
US Aircraft Industry Output

Value in 2021 $ Billions

Total US Deliveries By Value

US Output % of World

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Covid-19 Impact: Not Much New; Just An Acceleration of Pre-existing Trends

- **Societal:** growing inequality, growth of e-commerce over stores, movie theaters decline, normalization of formerly fringe beliefs, rising illiberal democracies.
- **Macroeconomic:** lower interest rates, excess savings, few investment opportunities, cheaper fuel, China de-coupling.
- **Industry:**
  - More point-to-point international routes (fragmentation); related demand for smaller, mid-range jets.
  - End of quadjets, marginalization of all larger jets.
  - Growing reliance on third party jetliner finance.
  - Jetliner price deflation.
  - Supplier rationalization, particularly 3/4th tier.
  - New product funding drought.
  - China indigenous substitute product development
  - Boeing single aisle breadth concerns; Airbus mid-market dominance.
  - Rolls-Royce under pressure.
  - OEMs and airlines: strong get stronger, weak get weaker.
  - Uncertain search for various alternative propulsion/fuel concepts.
- **K-patterns everywhere:** Domestic/int’l traffic, single aisles/twins, developed/emerging, bizav/scheduled, etc.
Concluding Observations, and A Few Consolations

• Civil aviation might get worse, depending on the Delta variant.
  • But, if not... a very steep decline will lead to record growth numbers in the recovery, with attendant exuberance.
• Boeing faces a very serious mid market challenge.
• For companies, all about the work portfolio.
• Defense companies can grow their civil side. Will they?
• High defense spending may complicate the civil recovery.
• There is some good news:
  • An airline paradise, except for the traffic (and, perhaps, fuel).
    • Jet costs, Crew costs, interest rates, government support (for most, and for now); Stimulate traffic, or restore profit?
  • Defense: budgets, export demand, industrial support.
  • Less business jet frothiness.
  • Financial sector stronger this time (“2008 was worse; you couldn’t print money.”). Good for jetliners and for suppliers.
• A relatively isolated (severe) jetliner-only downturn is our baseline.
World Aircraft Deliveries By Value, 1989-2030

- Military
- Civil (January 2020)
- Civil (August 2021)
Divergent Delivery Recovery Paths

Twin Aisles Are A Long-Term Concern

Military Bizav Rotorcraft Regionals (2018 peak)
SA Jets (2018 peak) TA Jets World GDP (IMF)